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Study of Fluid Flow in Gedongsongo Temple Manifestation Geothermal Based on the Data of Geophysics

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Abstract

Research of several geophysics methods has been done i.eis geo-electric, Spontaneous-Potential (SP), and shallow temperature. This research aimed to make a model of fluid flow on geothermal manifestation in the Gedongsongo region. The data taking has done on December 2012. This geo-electric method shows that the depth of caprock layer is at the depth of 130 m from the surface. SP method shows the fluid flow turn to the South-East and thermoelectric effect is huge so that occurred convection-current in the region around fumarole. Shallow temperature method indicated that temperature distribution of 20 – 70^{0}C.

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Keywords: fluid flow, geo-electric, spontaneous-potential, shallow temperature, geothermal, gedongsongo

1. Introduction

Geothermal is one of alternative resources and very to produced in Indonesia due to geothermal potential in Indonesia reaching 40% world geothermal reserve. This is caused Indonesia has 129 volcanoes which potentially as geothermal development region [1].

Ungaran volcano which located in Semarang Regency, Province of Central Java is one of geothermal prospect regions which is not developed yet with potential 50 MWe. [2] do geophysics research at Ungaran volcano by using various methods gravity, Spontaneous Potential (SP), seismic, infra-red image, and measurement of shallow surface temperature (Fig. 1). The result shows the fluid flow coming from south side of the top of Ungaran volcano and flowing toward South East.

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Some of the fluids appear to the surface as geothermal manifestation which located at Gedongsongo region, such as fumarole, hot water and alteration region**.** Spontaneous-Potential (SP), and shallow temperature at the Gedongsongo region.

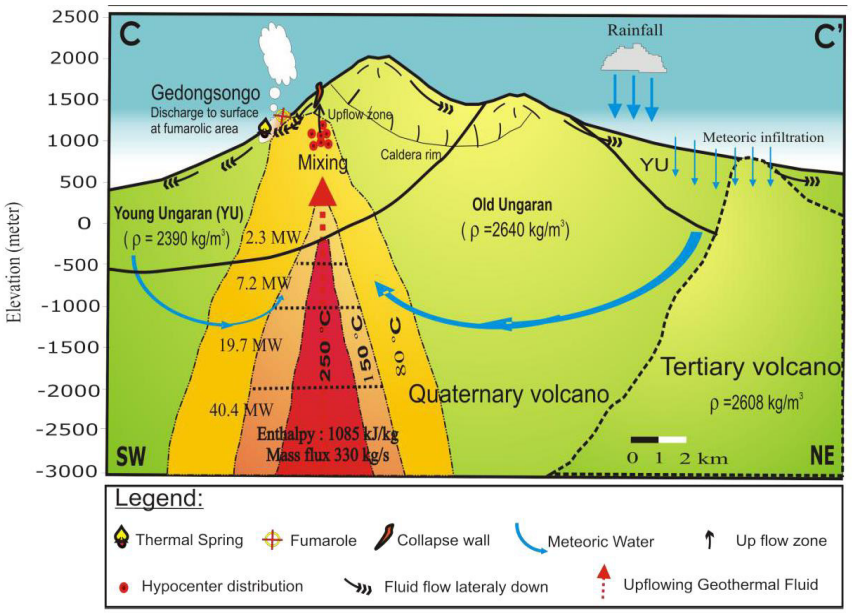

Fig. 1. Pattern of the sub surface fluid flow and its relevancy with the position of fluid output manifestation in the geothermal system model [3].

2. Geology of ungaran volcano

Ungaran volcano is the volcano with stratum volcanic typed which consist of andesite rock and toadstone. Product of the stratum volcanic form contact with tertiary formation [4].According to Ungaran Volcano in its development experiencing tectonic-collapsing which caused by gravity displacement because of the base is weak. The Ungaran volcano showed two growth class separated by rubble. The first Ungaran produces andesite rock at Under Pliosen Period, at Middle Pliosen the result more have the quality of andesite and end in rubble. The second cycle starts at Upper Pliosen Period and Holosen. The activity produces cycle of the second and third Ungaran.

[3] stratigraphy elucidated the Ungaran Volcano consist of rocks lava andesite, lava perlitic, andbrexia volcanic during the second and third of Ungaran (Fig. 2). Geology structure of Ungaran region is controlled by collapse structure which longitudinal from the west to the southeast of Ungaran. Volcanic rock compiler of pre-caldera is controlled by shear system which has an aim at northwest-southwest and southeast-southwest, whereas volcanic rock compiler of post-caldera is only contain a bit structure where this structure is controlled by regional shear system

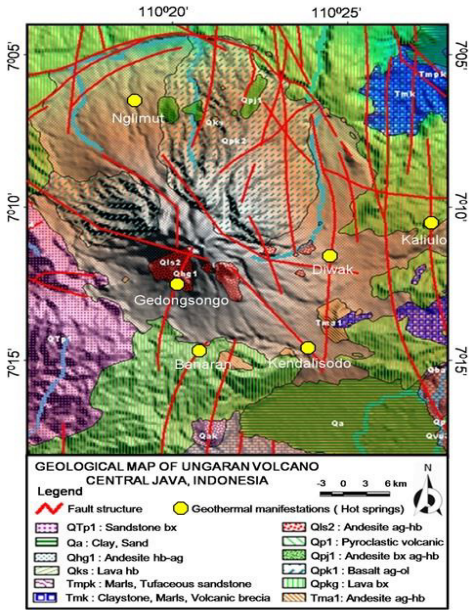

Fig. 2. Geological Map of Ungaran Volcano [2].

3. Method

Research was conducted on December 2012 in the geothermal manifestation area Gedongsongo, south slope of the Ungaran volcano (Fig. 3). This research implement by several methods that is Geo-electric, Spontaneous-Potential (SP), and shallow temperature.

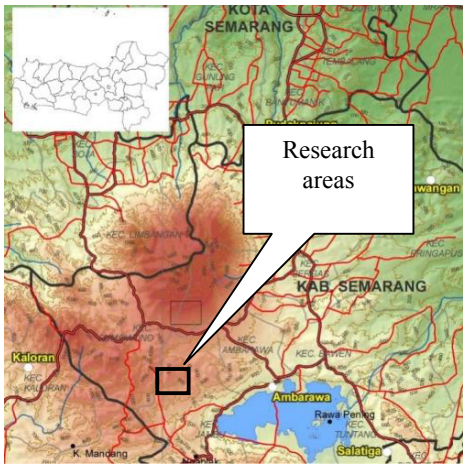

Fig. 3. The map of research area Semarang Regency.

3.1. Geoelectric method

The interpretation of geo-electric data is used geo-electric ID with Schlumberger configuration by variation of spread (current) AB/2 from 1.5 to 250 m with the spread of potential electrode (MN/2) by variation of spread 0.5 to 20 m (Fig. 4). In this geo-electric interpretation is done 3 measuring points, point 1 -$7^0$12.317' SL $110^0$20.231' LE, point 2 -$7^0$12.197' SL $110^0$20.408' LE, point 3 -7^0 12.317' SL $110^0$20.637' LE (Fig. 5).

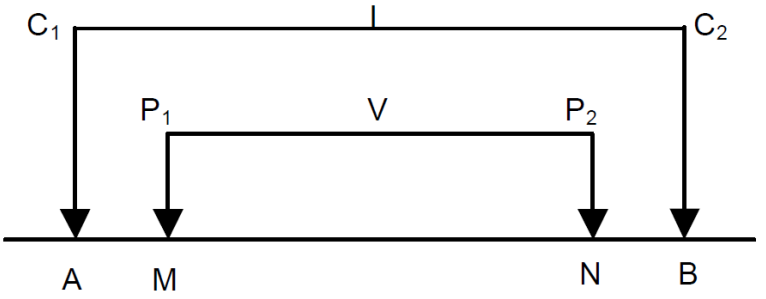

Fig. 4. Scheme of the geo-electric method Schlumberger configuration [5].

3.2. Spontaneous-Potential (SP)method

The interpretation of SP data are using amplitude potential method. The amplitude potential method is set with an electrode somewhere as binding point (base), whereas the other electrode is removed with certain distance through the path which will be measured (Fig. 5). Porous pot tube that connected to digital multi meter is put into measuring hole. Depth of the hole is ± 15 cm. Distance of the observation point one to another is 30 meter. The interpretation of data SP is coincide with the interpretation of shallow temperature. The interpretation of SP data observation in 30 observation points (Fig. 6).

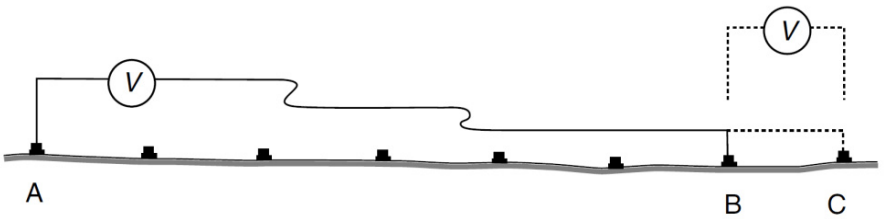

Fig. 5. Moving base in an SP survey. The value at the new base (B) relative to A is measured directly and also indirectly by measurement of the voltage at the field point C relative to both bases. [6].

3.3. Shallow surface temperature method

Interpretation data of shallow surface temperature was measure after the interpretation of SP data finished. The used of hole was similar to the interpretation hole of SP data surface that is by depth 75 cm – 100 cm from the surface. Temperature sensor thermocouplewas used in this research. Thermocouple sensor which has coupled, to the backing iron, is was put into the prepared hole. Process of data interpretation measured after the sensor is hushed for ± 10 minutes, this intended the sensor can measure the value of sub surface temperature correctly. Sensor thermocouple was connected to temperature to indicate value of temperature received by sensor thermocouple in the form of digital number. The experiment observed31 point resulted as experiment data (Fig. 6).

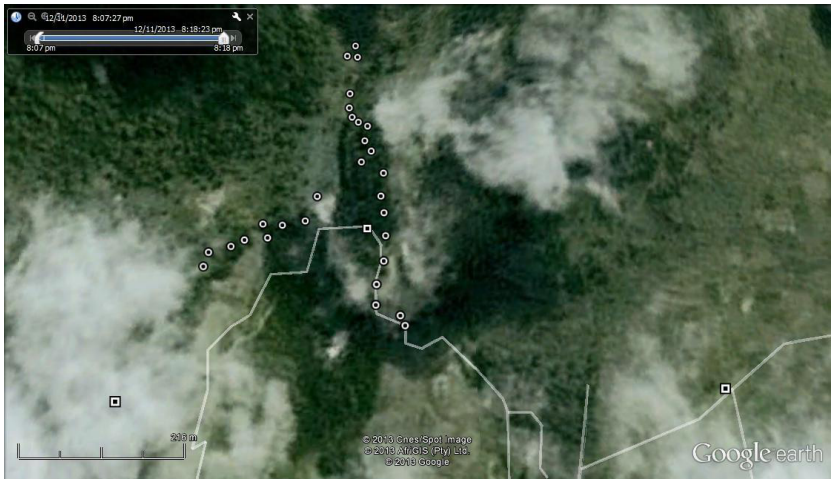

Fig. 6. Map of the measurement point of Spontaneous-Potential (SP) and Shallow temperature (○ symbol) and geo-electric point (□ symbol).

4. Result and discussion

Data of geo-electric measurement was computed by IPI2win softwareand resulted as graphics. The specific resistance value of each rock stratum and its depth in the ground also could be analyse from IPI2win software. After getting the value of specific resistance and its depth then can be used as reference to make two dimensional section manually on each path. First path consist of 1-2-3point (fig 7) and described section from manual process.

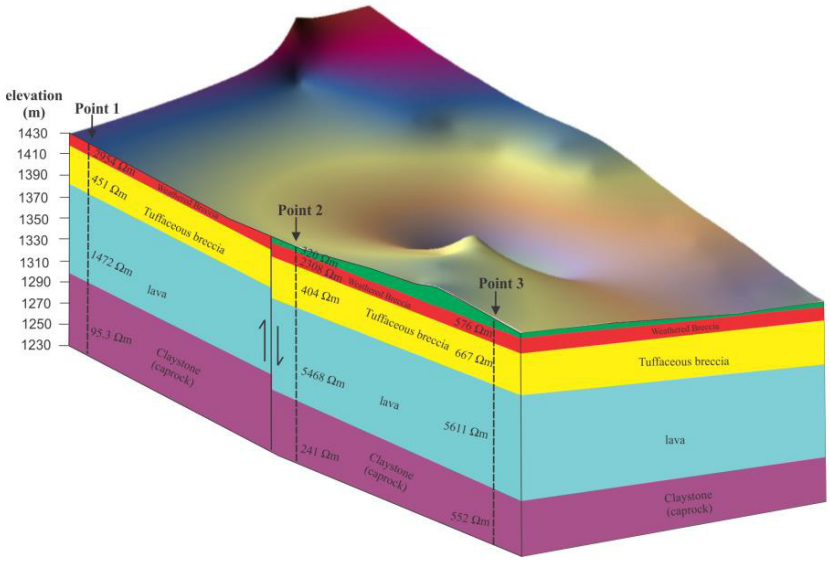

Fig. 7. Sub-surface section of the path at point 1-2-3.

Last path described clay rock stratum with resistivity about 95 – 552 ohm m with depth of 133 m to undetected. According to its location that in the deeper depth attained ± 130 m, this stratum was estimated as stratum cap rock / cover. This stratumhas the quality of impermeable in the system of each cover rock stratum in the structure of geothermal system stratum. Previous result estimated that between point 1 and 2 there is were certain shear that fit in with geology map. This structure that causing the flow out of geothermal manifestation on the surface proceed from the presence of shearing in the form of the descending shear which play role as weak zone the place-out for fluid to the surface.

Data of Spontaneous-Potential (SP) measurement is processed with software Surfer version 11.0 to obtain SP mapping contour seen in (Fig. 8). SP value in the research area is -45mV to 95 mV. Contour of Spontaneous-Potential (SP) shows the presence of low anomaly at some points identifying the presence of shearing zone which filled by fluid. The SP value in Geothermal region will be influenced by thermoelectric effect, where region that experiencing convection-current will show the anomaly of SP value.

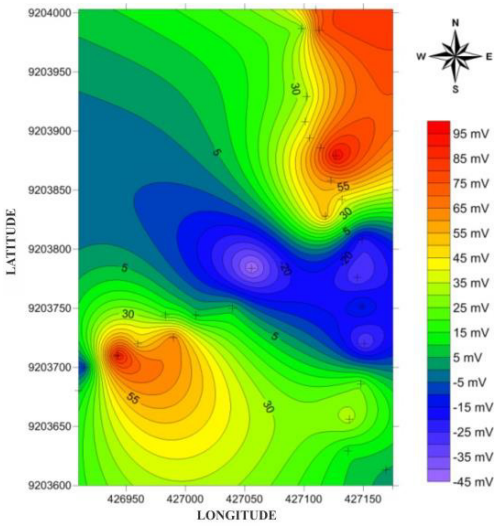

Fig. 8. The Spontaneous-Potential (SP) map of Gedongsongo region.

Shallow surface temperature from the measurement of shallow surface temperature produced by sub surface geothermal system. The movement of hot fluid and hot steam through heat transfer by from convection and heat transfer by way of conduction with the rocks throw down the heat up to close by surface. In the geothermal system contained hydrothermal systems which consist of water-keeping system, heating process and reservoir system. Reservoir is the heat source coming from water-keeping system process and heating process. Result of the research is obtained data shown in (Fig. 9). Temperature value in research area 20^0C to 70^0C of temperature distribution contour which show that in fumarole region has the highest temperature value because of in fumarole region is the place-out for hot steam coming directly from reservoir.

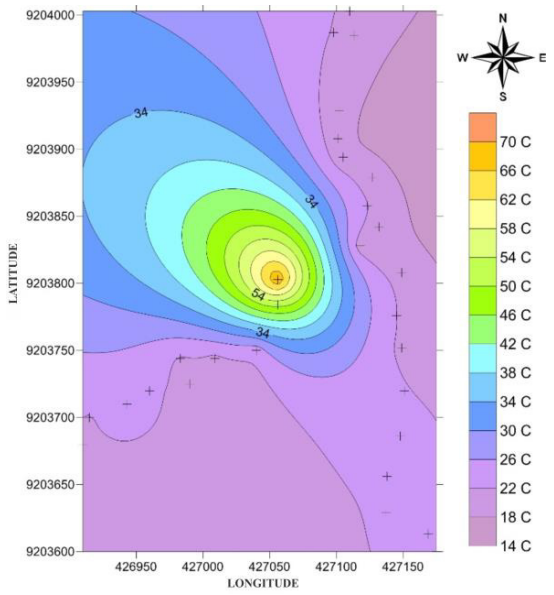

Fig. 9. The shallow temperature map of Gedongsongo region.

5. Conclusions

According to result of the research can be obtained conclusions. Contained the presence of shear structure where have a role as weak zone the place-out of fluid to the surface and with the cap rock depth about ± 130 meter.In the researches results of Spontaneous-Potential (SP) and shallow temperature also show that occurred anomaly in the region around the fumarole. This matter show the presence of fluid flow which ascending to the surface which is in the form of hot steam. Gedongsongo region is estimated as an up flow zone out of geothermal system of Ungaran volcano.

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